(54) Title: OPTICAL RECORD CARRIER RECORDING METHOD, OPTICAL RECORD CARRIER AND APPARATUS FOR WRITING INFORMATION

(57) Abstract: Described is an optical record carrier recording method, optical record carrier (11) and an apparatus for writing information to an optical record carrier (11). The optical record carrier recording method forms pits and lands by controlling a radiation source to direct a radiation beam onto a recording surface of an optical record carrier (11), the method comprises the steps of: reading a write strategy from the optical record carrier (11) which comprises at least two write strategies, and forming the pits and lands by controlling the radiation source with the read write strategy, wherein the method further comprises a step of determining which of the at least two write strategies is the most optimal one by reading an indication present on the optical record carrier (11), and wherein the method uses the most optimal write strategy to form the pits and the lands. If an apparatus for writing information to an optical record carrier (11) is capable of applying two or more write strategies stored on the optical record carrier, then the apparatus reads the indication and applies the write strategy which is the most optimal one.

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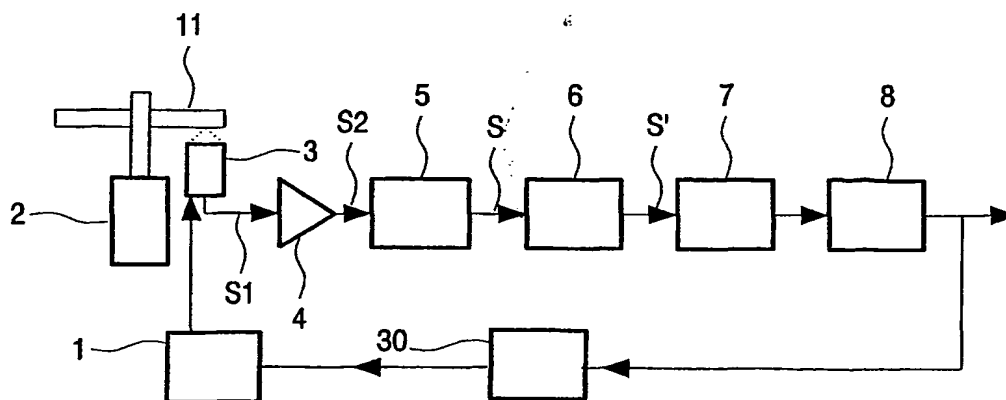TM, TN, TR, TT, TZ, UA, UG, UZ, VC, VN, YU, ZA, ZM,
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Optical record carrier recording method, optical record carrier and apparatus for writing
information

The invention pertains to an optical record carrier method for forming pits and
lands by controlling a radiation source to direct a radiation beam onto a recording surface of
an optical record carrier.
The invention further pertains to an optical record carrier.
5   The invention also pertains to an apparatus for writing information to an
optical record carrier.

Optical media store data in digital form, and include all the various CD and
10   DVD and Blu-ray Disc optical disk technologies. The data stored on this media can consist of
video, text, audio, computer data, or any other form of digital information. This data is
written to and read from an optical disk using a laser.
There are various manufacturers of optical disks. Therefore many different
formats and disk types are commercially available. Even within a standardized disc format,
15   such as for example CD-R, CD-R/W, DVD-R, DVD-R/W, BD+R, BD+R/W, each type of
optical disk may possess different material parameters. Because of this, each type may
behave differently when exposed to a write pulse from a laser. If uncompensated, these
differences in behavior result in variations in write performance, such as for example in the
jitter and the asymmetry of the written marks. Therefore, for optimum write performance
20   each type of optical disk may require a different write strategy to compensate for its material
parameters and other characteristics.
In this application a mark is understood to be any type of optically detectable
area on an optical disk. It includes a pit formed by locally heating the area on the optical disk
and amorphous areas in a crystalline layer in the optical disk. A write strategy is understood
25   to be any sequence of laser pulses, generated by the laser, causing a mark to be formed on the
optical disk when irradiated by the laser pulses.
In one approach an optimal writing strategy is developed for each optical disk
by conducting a test writing before attempting to write user information to the disk. The test
writing is, in general, made on an inner portion of a lead-in area of the optical disk while

incrementally adjusting the write power. Next, the recorded information is read from the test
area. The write power at which the desired quality (for example a lowest error rate, an
optimum modulation factor, or a lowest jitter factor) and asymmetry of the test writing is
obtained is selected as the optimum write power, which is thereafter used for actual recording

5   of user information. However, this approach is disadvantageous in that the results of the test
writing are not retained by the disk drive. Therefore, the test writing must be repeated, even
on optical disks of the same type, which can be burdensome. Furthermore, each parameter of
the write strategy must be developed for each disk, thereby requiring a significant analysis of
the characteristics of the test writing.

10   Another approach requires each optical disk type to be "registered" by an
optical disk drive when that drive is manufactured. During the development of an optical disk
drive, its manufacturer investigates and develops an optimal write strategy for each type of
optical disk of which the drive manufacturer is aware. The manufacturer then compiles data
representing a list of compatible optical disk types along with the corresponding optimal

15   write strategy for each optical disk type. This data is often stored in the optical disk drive in a
control information memory such as for example an EEPROM, and may contain such
recording parameters as the optimum write power, the time modulation, the linear velocity,
and the recording speed. A drive then can recognize a particular optical disk type by scanning
the lead-in portion of the disk. The characteristics of the lead-in portion of each optical disk

20   type varies by disk manufacturer, thus identifying the manufacturer of the disk.

In WO 03/03153 a method and recording device are disclosed which select
and learn an optimal write strategy by testing the performance of different known write
strategies, selecting the best write strategy for the particular optical disk type, and storing that
information for use when the same optical disk type is subsequently encountered.

25   Information about the best write strategy will be stored in the recording device for use when
the same optical disk type is subsequently encountered. However, the information about the
best write strategy for use with a specific disk is written to the disk itself. When the disk is
subsequently encountered, this information is read from the disk and used by the recording
device for selecting the best write strategy.

30   An apparatus for writing information to an optical record carrier is capable of
applying certain write strategies. However, if for a certain type of optical record carrier a new
write strategy is developed, it is possible that the apparatus is incapable of applying the new
write strategy. Therefore, it is common to write more than one write strategy onto the optical
record carrier. The apparatus can then select a write strategy which he can apply. However, if

at least two write strategies are written onto the optical record carrier, and the apparatus is capable of applying both, the apparatus does not know which one is the most optimal for that optical record carrier. In the case that even more write strategies are stored onto the optical record carrier the choice becomes even bigger and more likely that not the most optimal write

5   strategy is chosen. The most optimal write strategy also depends on the writing speed with which data is written on the optical record carrier.

It is therefore an object of the present invention to provide an optical record carrier recording method which is capable of determining the most optimal write strategy.

It is also an object of the present invention to provide an optical record carrier

10   to be used in such a method.

It is a further object of the present invention to provide an apparatus for writing information to an optical record carrier which is capable of determining the most optimal write strategy.

15

According to the invention this object is achieved with an optical record carrier method for forming pits and lands by controlling a radiation source to direct a radiation beam onto a recording surface of an optical record carrier, the method comprising the steps of:

20   reading a write strategy from the optical record carrier which comprises at least two write strategies, and

forming the pits and lands by controlling the radiation source with the read write strategy,

wherein the method further comprises a step of determining which of the at

25   least two write strategies is the most optimal one by reading an indication present on the optical record carrier, and wherein the method uses the most optimal write strategy to form the pits and the lands.

According to the invention the optical record carrier comprises at least two write strategies, wherein the optical record carrier further comprises an indication which of

30   the at least two write strategies is the most optimal one.

The apparatus for writing information to an optical record carrier comprises:

a write head for generating a radiation beam and directing the beam onto a recording surface of the optical record carrier,

reading means for reading information stored on the optical record carrier,

a write head controller for controlling the write head with a write strategy,

a processor for controlling the apparatus, the processor being capable of carrying out the method according to the invention.

If an apparatus for writing information to an optical record carrier is capable of
5   applying two or more write strategies stored on the optical record carrier, then the apparatus reads the indication and applies the write strategy which is the most optimal one.

If there are write strategies present on the optical record carrier which can not be applied by the apparatus then the apparatus has to determine which of the write strategies it can apply is the most optimal one. Therefore in an embodiment of the present invention the
10   indicator further indicates in which order the write strategies are preferred for the optical record carrier on which the indicator is stored and wherein the method is capable of determining which of the write strategies can be applied by the method and wherein the method determines from the applicable write strategies which is the most optimal one, the method thereby using the order of preference indicated by the indicator. For instance, if there
15   are three write strategies present an the most optimal one can not be applied by the method, than the apparatus picks the write strategy is the second optimal one.

The indication can be in the form of additional information stored on the optical record carrier, such as byte after each write strategy which value indicates how optimal that write strategy is. How optimal the write strategies are can also be indicated by
20   the sequential order in which the write strategies are stored on the optical record carrier. For instance, the write strategies can be stored in a disc information table present in a zone of the optical record carrier called the Control Data Zone. The first write strategy in the disc information table is the most optimal one. The second write strategy in the disc information table is the second most optimal one, and so on.

25   In a further embodiment of the present invention the method reads an additional byte contained in the write strategies which additional byte describes a write velocity for which the write strategy can be applied and wherein the method reads the additional information by reading an additional bit or byte contained in the write strategies which indicates if the write strategy is the most optimal one for that write velocity. The
30   apparatus performing this method and which is capable of writing at different writing velocities, can select the most optimal write strategy dependent on the writing velocity.

These and other aspects of the apparatus, information carrier and method according to the invention will be apparent from and elucidated by means of the drawings, in which:

Fig. 1 shows an apparatus for writing information according to the invention,

Fig. 2a shows an information carrier (top view),

Fig. 2b shows an information carrier (cross section),

Fig. 3 shows an example of the information zone of an information carrier,

Fig. 4 shows a table of an example of physical format information,

Fig. 5 shows a flow chart of a optical record carrier recording method in accordance with the invention.

The apparatus for writing information shown in Fig. 1 comprises a write head 3 for reading the information from an information carrier 11. A displacement means 2 is able to cause a relative displacement between the information carrier 11 and the write head 3. In operation, an output signal S_1 of the read head 3 is fed to an amplifier 4. The amplifier 4 amplifies the output signal S_1 to a desired level and supplies an amplified signal S_2 to an analog to digital A/D converter 5. The A/D converter 5 converts the amplified signal S_2 to a sampled read signal S, using a sampling period of T seconds. The sampled read signal S is fed to the waveform equalizer 6. The waveform equalizer 6 obtains a corrected signal S' by performing a waveform equalization to the read signal S. The output of the waveform equalizer 6 is fed to bit-detection means 7. The output of the bit-detection means 7 is fed to channel decoding means 8. The write head is controlled by the write head controller 1. The processor 30 controls the apparatus. The processor 30 controls the write head 3 to read out the indicator and then determines the most optimal write strategy indicated by the indicator. If the most optimal write strategy can be applied by the apparatus, then the write head controller 1 is provided with the optimal write strategy. Writing information is subsequently performed by using the most optimal write strategy.

Fig. 2a shows a disc-shaped information carrier 11 having a track 9 and a central hole 10. The track 9, being the position of the series of (to be) recorded marks representing information, is arranged in accordance with a spiral pattern of turns constituting substantially parallel tracks on an information layer. The information carrier may be optically readable, called an optical disc, and has an information layer of a recordable type. Examples of a recordable disc are the CD-R and CD-RW, and writable versions of DVD, such as

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DVD+RW. Further details about the DVD disc can be found in reference: *ECMA-267: 120 mm DVD – Read-Only Disc - (1997)*. The information is represented on the information layer by recording optically detectable marks along the track, e.g. crystalline or amorphous marks in phase change material. The track 9 on the recordable type of information carrier is

5   indicated by a pre-embossed track structure provided during manufacture of the blank information carrier. The track structure is constituted, for example, by a pregroove 14 which enables a read/write head to follow the track during scanning. The track structure comprises position information, e.g. addresses, for indication the location of units of information, usually called information blocks. The position information includes specific synchronizing

10   marks for locating the start of such information blocks. The position information is encoded in frames of modulated wobbles as described below.

Fig. 2b shows a part of a cross-section taken along the line b-b of the information carrier 11 of the recordable type, in which a transparent substrate 15 is provided with a recording layer 16 and a protective layer 17. The protective layer 17 may comprise a

15   further substrate layer, for example as in DVD where the recording layer is at a 0.6 mm substrate and a further substrate of 0.6 mm is bonded to the back side thereof. The pregroove 14 may be implemented as an indentation or an elevation of the substrate 15 material, or as a material property deviating from its surroundings.

The information carrier 11 is intended for carrying information represented by

20   modulated signals comprising frames. A frame is a predefined amount of data preceded by a synchronizing signal. Usually such frames also comprise error correction codes, e.g. parity words. A number of such frames constitute an information block, the information block comprising further error correction words. The information block is the smallest recordable unit from which information can be reliably retrieved. An example of such a recording

25   system is known from the DVD system, in which the frames carry 172 data words and 10 parity words, and 208 frames constitute an ECC block.

Fig. 3 shows an example of the information zone 20 of an information carrier 11. The information zone 20 contains all the information on the information carrier relevant for data interchange. The Inner Drive Area 21 and Outer Drive Area 25 are meant for disc

30   testing. The Lead-in Zone 22 contains control information. The Lead-out Zone 24 allows for a smooth lead-out and also contains control information. The Data zones 23 are intended for recording of user data. The Lead-in Zone contains a Control Data Zone.

Fig. 4 shows a table of an example of physical format information contained in the Control Data Zone. The Physical format information is encoded in ADIP as described

above. This information shall comprise the 256 bytes shown in Fig. 4. It contains disc information and values used for the Optimum Power Control (OPC) algorithm to determine optimum laser power levels for writing. The information is copied into a recordable zone called the Control Data during initialization of the disc. The data contents are for example:

5   **Byte 0 - Disc Category and Version Number**

Bits b7 to b4   shall specify the Disc Category,

they shall be set to 1010, indicating a DVD+R disc.

Bits b3 to b0   shall specify the Version Number,

they shall be set to 0000 indicating the version

10   **Byte 1 - Disc size and maximum transfer rate**

Bits b7 to b4   shall specify the disc size,

they shall be set to 0000, indicating a 120 mm disc

Bits b3 to b0   shall specify the maximum read transfer rate,

they shall be set to 1111 indicating no maximum read transfer rate is

15   specified

Byte 2 - Disc structure

Bit b7 to b4   shall be set to 0000

Bits b3 to b0   shall specify the type of the recording layer(s):

they shall be set to 0010, indicating a write-once recording layer.

20   **Byte 3 - Recording density**

Bits b7 to b4   shall specify the average Channel bit length in the Information Zone,

they shall be set to 0000, indicating 0,133 µm

Bits b3 to b0   shall specify the average track pitch,

they shall be set to 0000, indicating an average track pitch of 0,74 µm

25   **Bytes 4 to 15 - Data Zone allocation**

Byte 4   shall be set to (00).

Bytes 5 to 7   shall be set to (030000) to specify PSN 196.608 of the first Physical Sector of the Data Zone

Byte 8   shall be set to (00).

30   Bytes 9 to 11   shall be set to (26053F) to specify PSN 2.491.711 as the last possible Physical Sector of the Data Zone.

Bytes 12 to 15 shall be set to (00)

Byte 16 – (00)shall be set to (00).

Byte 17 - Reserved. This byte is reserved and shall be set to (00).

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Byte 18 – Extended information indicators

Bits b7 to b6   are reserved and shall be set to 00

Bits b5 to b0   each of these bits shall indicate the presence of an Extended

Information block. Bit b_i shall be set to 1 if Extended Information

5   block i, consisting of bytes $(64 + i \times 32)$ to $(95 + i \times 32)$, is in use. Else bit

b_i shall be set to 0.

Bytes 19 to 26 – Disc Manufacturer ID.

These 8 bytes shall identify the manufacturer of the disc. Trailing bytes not

used shall be set to (00).

10   **Bytes 27 to 29 – Media type ID.**

Disc manufacturers can have different types of media, which shall be specified

by these 3 bytes. The specific type of disc is denoted in this field.

Byte 30 – Product revision number.

This byte shall identify the product revision number in binary notation. All

15   discs with the same Disc Manufacturer ID and the same Product ID, regardless

of Product revision numbers, must have the same recording properties (only

minor differences are allowed: Product revision numbers shall be irrelevant for

recorders). If not used this byte shall be set to (00)

        Byte 31   **number of Physical format information bytes in use.**

20   This byte forms one 8-bit binary number indicating the number of bytes

actually in use for Physical format information. It shall be set to (36)

indicating that only the first 54 bytes of the Physical format information are

used.

Byte 32 – Reference recording velocity.

25   This byte indicates the lowest possible recording velocity of the disc, which is

also referred to as the Reference velocity, as a number n such that

$$n = 10 \times v_{ref} \text{ (n rounded off to an integral value)}$$

It shall be set to (23) indicating a Reference writing speed of 3,49 m/s.

Byte 33 – Maximum recording velocity.

30   This byte indicates the highest possible recording velocity of the disc, as a

number n such that

$$n = 10 \times v_{ref} \text{ (n rounded off to an integral value)}$$

It shall be set to (54) indicating a maximum writing speed of 8,44 m/s.

Byte 34 – Wavelength λIND.

This byte shall specify the wavelength in nanometers of the laser with which the optimum write parameters in the following bytes have been determined, as a number n such that

n = Wavelength − 600

5   **Byte 35   Reserved**

Byte 36   Maximum read power, Pr at reference velocity.

This byte shall specify the maximum read power Pr in milliwatts at the reference velocity as a number n such that

$$n = 20 \times (Pr - 0,7)$$

10   **Byte 37 - PIND at reference velocity.**

PIND is the starting value for the determination of Ppo used in the OPC algorithm. This byte shall specify the indicative value PIND of Ppo in milliwatts at the reference velocity as a number n such that

$$n = 20 \times (P_{IND} - 5)$$

15   **Byte 38 - β_{target} at reference velocity.**

This byte shall specify the target value for β, β_{target} at the reference velocity used in the OPC algorithm as a number n such that

$$n = 10 \times \beta_{target}$$

Byte 39 - Maximum read power, Pr at maximum velocity.

20   This byte shall specify the maximum read power Pr in milliwatts at the maximum velocity as a number n such that

$$n = 20 \times (Pr - 0,7)$$

Byte 40 - P_{IND} at maximum velocity.

P_{IND} is the starting value for the determination of Ppo used in the OPC

25   algorithm. This byte shall specify the indicative value PIND of Ppo in milliwatts at the maximum velocity as a number n such that

$$n = 20 \times (PIND - 5)$$

Byte 41 - β_{target} at maximum velocity.

This byte shall specify the target value for β, β_{target} at the maximum velocity

30   used in the OPC algorithm as a number n such that

$$n = 10 \times \beta_{target}$$

Byte 42 - Ttop ($\geq$4) first pulse duration for current mark $\geq$4 at reference velocity.

This byte shall specify the duration of the first pulse of the multi pulse train when the current mark is a 4T or greater mark for recording at reference velocity. The value is expressed in fractions of the channel bit clock period as a number n such that

$$n = 16 \times \frac{T_{top}}{T_W} \quad \text{and} \quad 4 \leq n \leq 40$$

Byte 43 - Ttop (=3) first pulse duration for current mark =3 at reference velocity.

This byte shall specify the duration of the first pulse of the multi pulse train when the current mark is a 3T mark for recording at reference velocity. The value is expressed in fractions of the channel bit clock period as a number n such that

$$n = 16 \times \frac{T_{top}}{T_W} \quad \text{and} \quad 4 \leq n \leq 40$$

Byte 44 - Tmp multi pulse duration at reference velocity.

This byte shall specify the duration of the 2nd pulse through the 2nd to last pulse of the multi pulse train for recording at reference velocity. The value is expressed in fractions of the channel bit clock period as a number n such that

$$n = 16 \times \frac{T_{mp}}{T_W} \quad \text{and} \quad 4 \leq n \leq 16$$

Byte 45 - Tlp last pulse duration at reference velocity.

This byte shall specify the duration of the last pulse of the multi pulse train for recording at reference velocity. The value is expressed in fractions of the channel bit clock period as a number n such that

$$n = 16 \times \frac{T_{lp}}{T_W} \quad \text{and} \quad 4 \leq n \leq 24$$

Byte 46 - dTtop first pulse lead time at reference velocity.

This byte shall specify the lead time of the first pulse of the multi pulse train relative to the trailing edge of the second channel bit of the data pulse for recording at reference velocity. The value is expressed in fractions of the channel bit clock period as a number n such that

$$n = 16 \times \frac{dT_{top}}{T_W} \quad \text{and} \quad 0 \leq n \leq 24$$

Byte 47 - dTle 1st pulse leading edge correction for previous space =3 at reference velocity.

Bit 7 to bit 4 of this byte shall specify the leading edge correction for the 1st pulse of the multi pulse train when the previous space was a 3T space for recording at reference velocity. The value is expressed in fractions of the channel bit clock period according to Fig. 8.

Byte 48 - Ttop (≥4) first pulse duration for current mark ≥4 at maximum velocity.

This byte shall specify the duration of the first pulse of the multi pulse train when the current mark is a 4T or greater mark for recording at maximum velocity. The value is expressed in fractions of the channel bit clock period as a number n such that

$$n = 16 \times \frac{T_{top}}{T_W} \qquad \text{and} \qquad 4 \leq n \leq 40$$

Byte 49 - Ttop (3) first pulse duration for current mark =3 at maximum velocity.

This byte shall specify the duration of the first pulse of the multi pulse train when the current mark is a 3T mark for recording at maximum velocity. The value is expressed in fractions of the channel bit clock period as a number n such that

$$n = 16 \times \frac{T_{top}}{T_W} \qquad \text{and} \qquad 4 \leq n \leq 40$$

Byte 50   Tmp multi pulse duration at maximum velocity.

This byte shall specify the duration of the 2nd pulse through the 2nd to last pulse of the multi pulse train for recording at maximum velocity. The value is expressed in fractions of the channel bit clock period as a number n such that

$$n = 16 \times \frac{T_{mp}}{T_W} \qquad \text{and} \qquad 4 \leq n \leq 16$$

Byte 51 - Tlp last pulse duration at maximum velocity.

This byte shall specify the duration of the last pulse of the multi pulse train for recording at maximum velocity. The value is expressed in fractions of the channel bit clock period as a number n such that

$$n = 16 \times \frac{T_{lp}}{T_W} \qquad \text{and} \qquad 4 \leq n \leq 24$$

Byte 52 - dTtop first pulse lead time at maximum velocity.

This byte shall specify the lead time of the first pulse of the multi pulse train relative to the trailing edge of the second channel bit of the data pulse for recording at maximum velocity. The value is expressed in fractions of the channel bit clock period as a number n such that

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$$n = 16 \times \frac{dT_{top}}{T_w} \qquad \text{and} \qquad 0 \leq n \leq 24$$

Byte 53 - dTle first pulse leading edge correction for previous space =3 at maximum velocity.

5   Bit 7 to bit 4 of this byte shall specify the leading edge correction for the 1st pulse of the multi pulse train when the previous space was a 3T space for recording at maximum velocity. The value is expressed in fractions of the channel bit clock period according to Fig. 8.

Bytes 54 to 63 - Reserved - All (00).

These bytes shall be set to all (00).

10   **Bytes (64 + i×32) to (95 + i×32) – Extended Information block i (i = 0..5)**

To facilitate future extensions, Extended Information blocks are introduced. Each such block consists of 32 bytes. These bytes can hold for instance parameters for an alternative write strategy, e.g. for High-Speed recording, or other advanced parameters. The presence of an Extended Information block

15   shall be indicated by a bit in byte 18.

Byte (64 + i×32) Extended Information block i version number indicates the block version and identifies the definitions of the data in bytes (64 + i×32) to (95 + i×32). A disc can have several Extended Information blocks of which the block version numbers can be the same as well as different.

20   Drives not acquainted with the specific block version number in block i, should not use the disc with the advanced parameters in this Extended Information block.

If the block version number is set to 255, the related Extended information block is not an independent block but a continuation of the preceding

25   Extended Information block (to be used if 32 bytes are not sufficient for a set of parameters).

Bytes (65 + i×32) to (95 + i×32)

these bytes can be used to hold alternative write strategies or other parameters.

Example for High-speed write strategy parameters

30   Byte 18   : 0000 0001 indicating Extended Information block 0 is in use.

Byte 64   : 0000 0001 indicating block version 1, for which bytes 65 to 95 have the following meaning:

Byte 65   : Maximum recording velocity for the parameter set in this EI block:

n × 0,25 m/s, (max ≤ 63,75 m/s = 18.25x = 175 Hz @ R = 58 mm)

Byte 66   : Minimum recording velocity for the parameter set in this EI block:

n × 0,25 m/s, (minimum recording velocity is allowed to be = maximum recording velocity)

Byte 67   : reserved and set to (00)

Byte 68 to 81 : parameter set for maximum recording velocity

byte 68:   PIND

byte 69:   βtarget

byte 70:   Ttop (≥4) first pulse duration for cm ≥4

byte 71:   Ttop (=3) first pulse duration for cm =3

byte 72:   Tmp multi pulse duration

byte 73:   Tlp last pulse duration

byte 74:   dTtop (≥4) first pulse lead time for cm ≥4

byte 75:   dTtop (=3) first pulse lead time for cm =3

byte 76:   dTle 1st pulse leading edge correction for ps =3

byte 77:   dTle 1st pulse leading edge correction for ps =4

byte 78:   reserved and set to (00)

byte 79:   reserved and set to (00)

byte 80:   reserved and set to (00)

byte 81:   reserved and set to (00)

Byte 82 to 95 : parameter set for minimum recording velocity

byte 82:   PIND

byte 83:   βtarget

byte 84:   Ttop (≥4) first pulse duration for cm ≥4

byte 85:   Ttop (=3) first pulse duration for cm =3

byte 86:   Tmp multi pulse duration

byte 87:   Tlp last pulse duration

byte 88:   dTtop (≥4) first pulse lead time for cm ≥4

byte 89:   dTtop (=3) first pulse lead time for cm =3

byte 90:   dTle 1st pulse leading edge correction for ps =3

byte 91:   dTle 1st pulse leading edge correction for ps =4

byte 92:   reserved and set to (00)

byte 93:   reserved and set to (00)

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byte 94:   reserved and set to (00)

byte 95:   reserved and set to (00)

    The indicator can be implemented by using one or more bytes of the physical

format information bytes. The value of these bytes indicates how optimal the write strategy is

5 for the optical record carrier on which the indicator is stored.

    For the different write velocities different write strategies are optimal. Also for

one write velocity different write strategies can be applicable. A way to indicate for the

different write velocity what write strategy is applicable is to us a byte [7..0] for each write

velocity:

10 -   Bits 7..4 describe the velocity (16 possible velocities)

       e.g. 0001 decodes for 1X (reference velocity)

          0111decodes for 7X

  -    Bits 3..0 describe which write strategy (out of four in this case) applies

       e.g. 0101: WS1 and WS3 are applicable

15   1000: WS4 is applicable

To describe which velocity is optimal at each velocity a byte per velocity is added:

  -    Bits 7..4 describe the velocity

       e.g. 0001 decodes for 1X (reference velocity)

          0111decodes for 7X

20 -   Bits 3..0 describe which velocity applies

       e.g. 0100: WS3 is optimal

          1000: WS4 is optimal

    In step 1 (100) of Fig. 5 the write strategies contained in the optical record

carrier which can be applied by the method are determined. In step 2 (101) the indicators of

25 the applicable write strategies are read. Subsequently, in step 3 (102), the most optimal write

strategy is determined. For instance, the write strategy with the highest indicator is the most

optimal one. Of course, the write velocity is also taken into account, i.e. only the write

strategies which are applicable for the write velocity at which the information should be

written are taken into account. Finally, in step 4 (103), the pits and lands are formed by

30 controlling the radiation source with the determined optimal write strategy.

CLAIMS:

1.   An optical record carrier recording method for forming pits and lands by controlling a radiation source to direct a radiation beam onto a recording surface of an optical record carrier, the method comprising the steps of:

       reading a write strategy from the optical record carrier which comprises at least two write strategies, and

       forming the pits and lands by controlling the radiation source with the read write strategy,

       wherein the method further comprises a step of determining which of the at least two write strategies is the most optimal one by reading an indication present on the optical record carrier, and wherein the method uses the most optimal write strategy to form the pits and the lands.

2.   An optical record carrier as claimed in claim 1, wherein the indicator further indicates in which order the write strategies are preferred for the optical record carrier on which the indicator is stored and wherein the method is capable of determining which of the write strategies can be applied by the method and wherein the method determines from the applicable write strategies which is the most optimal one, the method thereby using the order of preference indicated by the indicator.

3.   An optical record carrier recording method as claimed in claim 1 or 2, wherein the method concludes from a sequential order in which the at least two write strategies are stored on the optical record carrier which write strategy is the most optimal one.

4.   An optical record carrier recording method as claimed in claim 1 or 2, wherein the method determines the most optimal write strategy by reading additional information stored the optical record carrier.

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5.   An optical record carrier recording method as claimed in claim 4, wherein the method reads the additional information from in a Control Data Zone present in a lead-in zone of the optical record carrier.

5   6.   An optical record carrier recording method as claimed in claim 4, wherein the method reads an additional byte contained in the write strategies which additional byte describes a write velocity for which the write strategy can be applied and wherein the method reads the additional information by reading an additional bit or byte contained in the write strategies which indicates if the write strategy is the most optimal one for that write velocity.

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7.   An optical record carrier comprising at least two write strategies, wherein the optical record carrier further comprises an indication which of the at least two write strategies is the most optimal one.

15   8.   An optical record carrier as claimed in claim 7, the indicator further indicates in which order the write strategies are preferred for the optical record carrier on which the indicator is stored.

9.   An optical record carrier as claimed in claim 7 or 8, wherein a sequential order

20   in which the at least two write strategies are stored on the optical record carrier indicate which write strategy is the most optimal one.

10.   An optical record carrier as claimed in claim 7 or 8, wherein additional information stored on the optical record carrier indicates which write strategy is the most

25   optimal one.

11.   An optical record carrier as claimed in claim 10, wherein the additional information is stored in a Control Data Zone present in a lead-in zone of the optical record carrier.

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12.   An optical record carrier as claimed in claim 10, wherein the write strategies contain an additional byte describing a write velocity for which the write strategy can be applied and an additional bit or byte indicating if the write strategy is the most optimal one for that write velocity.

13.   An optical record carrier as claimed in claim 10, further comprising at least two additional bytes wherein each byte indicates for a write velocity which of the write strategies may be applied for that write velocity and wherein the optical record carrier further comprises at least two further additional bytes each byte indicating for a write velocity which of the write strategies is the most optimal one.

14.   An apparatus for writing information to an optical record carrier, comprising:

      a write head for generating a radiation beam and directing the beam onto a recording surface of the optical record carrier,

      reading means for reading information stored on the optical record carrier,

      a write head controller for controlling the write head with a write strategy,

      a processor for controlling the apparatus, the processor being capable of carrying out the method of one of the claims 1 to 6.
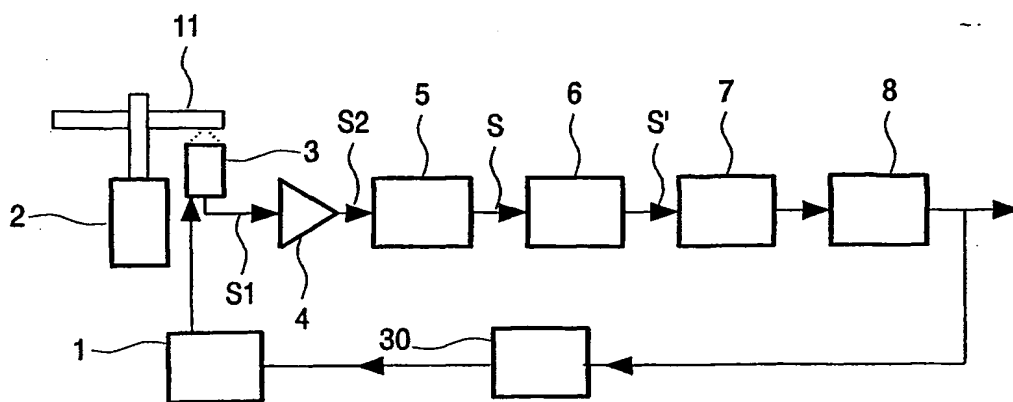
FIG. 1
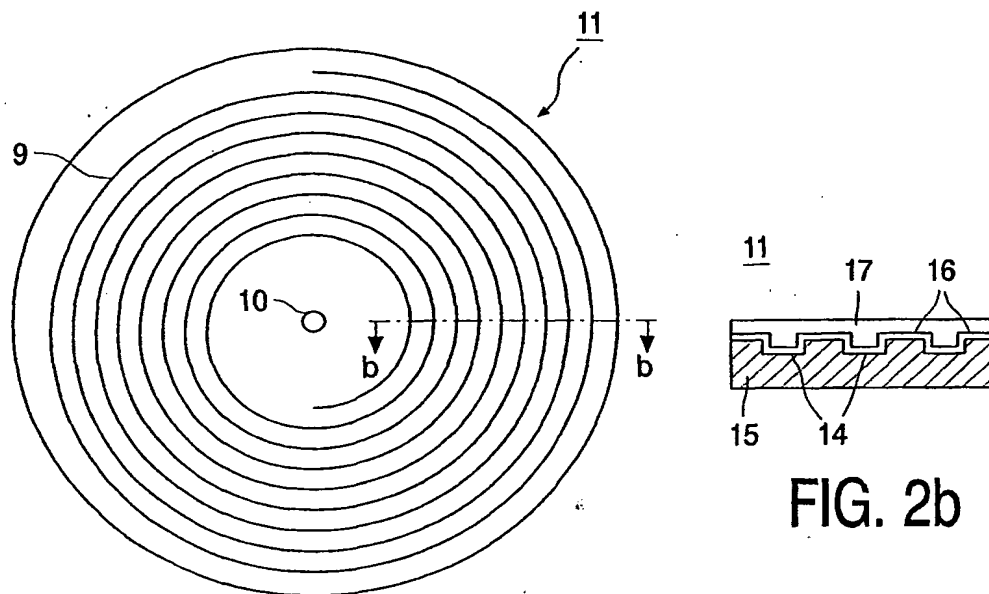
FIG. 2a

FIG. 2b
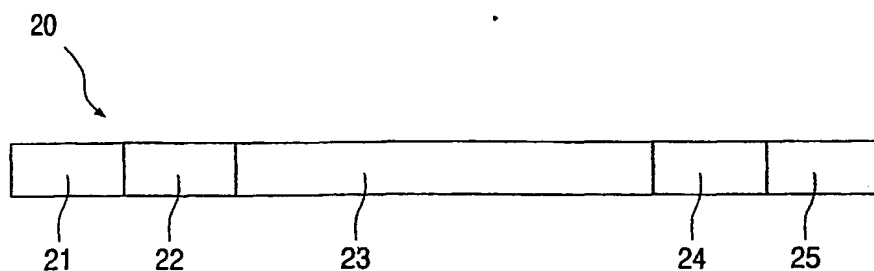
FIG. 3

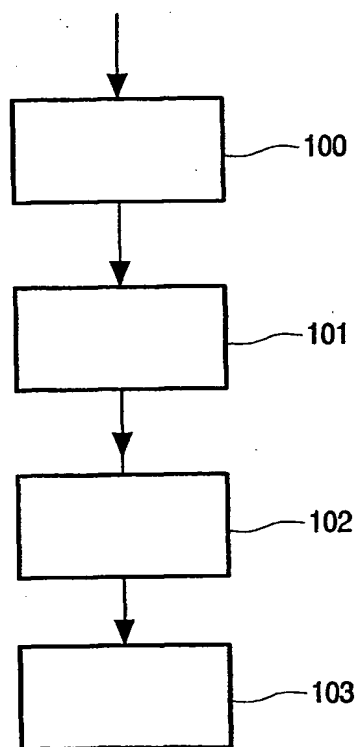| Byte number	Content	Number of bytes
0	**Disc Category and Version Number:** indicates the version of the disc and identifies the definitions of the data in bytes 0 to 63 (important for backwards compatibility). Drives not acquainted with the specific Version Number of a disc should not try to record on that disc using the information in bytes 0 to 63.	1
1	Disc size	1
2	Disc structure	1
3	Recording density	1
4 to 15	Data Zone allocation	12
16	Set to (00)	1
17	Reserved – All (00)	1
18	**Extended Information indicators**	1
19 to 26	Disc Manufacturer ID	8
27 to 29	Media type ID	3
30	Product revision number	1
31	number of Physical format information bytes in use in ADIP up to byte 63 (according to first generation: set to 56)	1
32	Reference recording velocity	1
33	Maximum recording velocity	1
34	Wavelength λ_{IND}	1
35	normalized Write power dependency on Wavelength $(dP/d\lambda)/(P_{IND}/\lambda_{IND})$	1
36	Maximum read power at reference velocity	1
37	P_{IND} at reference velocity	1
38	β_{target} at reference velocity	1
39	Maximum read power at maximum velocity	1
40	P_{IND} at maximum velocity	1
41	β_{target} at maximum velocity	1
42	T_{top} (≥4) first pulse duration for cm ≥4 at reference velocity	1
43	T_{top} (=3) first pulse duration for cm =3 at reference velocity	1
44	T_{mp} multi pulse duration at reference velocity	1
45	T_{lp} last pulse duration at reference velocity	1
46	dT_{top} (≥4) first pulse lead time for cm ≥4 at reference velocity	1
47	dT_{top} (=3) first pulse lead time for cm =3 at reference velocity	1
48	dT_{le} 1st pulse leading edge correction for ps =3 at reference velocity	1
49	T_{top} (≥4) first pulse duration for cm ≥4 at maximum velocity	1
50	T_{top} (=3) first pulse duration for cm =3 at maximum velocity	1
51	T_{mp} multi pulse duration at maximum velocity	1
52	T_{lp} last pulse duration at maximum velocity	1
53	dT_{top} (≥4) first pulse lead time for cm ≥4 at maximum velocity	1
54	dT_{top} (=3) first pulse lead time for cm =3 at maximum velocity	1
55	dT_{le} 1st pulse leading edge correction for ps =3 at maximum velocity	1
56 to 63	Reserved – All (00)	8
64 to 95	**Extended Information block 0**	32
96 to 127	**Extended Information block 1**	32
128 to 159	**Extended Information block 2**	32
160 to 191	**Extended Information block 3**	32
192 to 223	**Extended Information block 4**	32
224 to 247	**Extended Information block 5**	24
248 to 255	Reserved for use in the Control Data Zone– All (00)	8

FIG.4

FIG. 5

(54) Title: OPTICAL RECORD CARRIER RECORDING METHOD, OPTICAL RECORD CARRIER AND APPARATUS FOR WRITING INFORMATION

(57) Abstract: Described is an optical record carrier recording method, optical record carrier (11) and an apparatus for writing information to an optical record carrier (11). The optical record carrier recording method forms pits and lands by controlling a radiation source to direct a radiation beam onto a recording surface of an optical record carrier (11), the method comprises the steps of: reading a write strategy from the optical record carrier (11) which comprises at least two write strategies, and forming the pits and lands by controlling the radiation source with the read write strategy, wherein the method further comprises a step of determining which of the at least two write strategies is the most optimal one by reading an indication present on the optical record carrier (11), and wherein the method uses the most optimal write strategy to form the pits and the lands. If an apparatus for writing information to an optical record carrier (11) is capable of applying two or more write strategies stored on the optical record carrier, then the apparatus reads the indication and applies the write strategy which is the most optimal one.

ZW, ARIPO patent (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IT, LU, MC, NL, PL, PT, RO, SE, SI, SK, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG)

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B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7   G11B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the International search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 1 233 409 A (PIONEER CORPORATION) 21 August 2002 (2002-08-21) abstract paragraph '0059! - paragraph '0063!; figure 3	1,4-7, 10-12,14
A		2,3,8,9, 13

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☒ Patent family members are listed in annex.

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			US	2002114233 A1	22-08-2002

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